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This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regualtion in K083 and for developing treatment standards for these constituents. The document also provides waste characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K083 that is more difficult to treat than the wastes that were analyzed in developing treatment standards for K083.

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PROPOSED

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR DISTILLATION BOTTOMS FROM THE PRODUCTION OF ANILINE

K083

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Note: This proposed Background Document is being issued in support of the Agency's proposed rulemaking for the land disposal restrictions program. The Agency solicits comments on the proposed rule and on this proposed Background Document. This document will be issued in final form, appropriately revised in response to comments, at the time of promulgation of the final rule.

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
2.0	INDUSTRY AFFECTED AND WASTE CHARACTERIZATION	2-1
	2.1 Industry Affected and Process Description	2-1
	2.2 Waste Characterization	2-3
3.0	APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES	3-1
	3.1 Applicable Treatment Technologies	3-1
	3.2 Demonstrated Treatment Technologies	3-7
4.0	TREATMENT PERFORMANCE DATA BASE	4-1
	4.1 Organic Constituents	4-2
	4.2 Metal Constituents	4-4
5.0	IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)	5-1
6.0	SELECTION OF CONSTITUENTS PROPOSED FOR REGULATION	6-1
	6.1 BDAT List Constituents Not Selected for Proposed Regulation	6-2
	6.2 Selection of BDAT List Constituents for Proposed Regulation	6-4
7.0	CALCULATION OF PROPOSED BDAT TREATMENT STANDARDS	7-1
	7.1 Calculation of Proposed Treatment Standards for K083 Nonwastewaters	7-3
	7.2 Calculation of Proposed Treatment Standards for K083 Wastewaters	7-6
8.0	ACKNOWLEDGEMENTS	8-1
9.0	REFERENCES	9-1
	Appendix A - ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA	A-1

LIST OF TABLES

Table		Page
1-1	PROPOSED BDAT TREATMENT STANDARDS FOR K083 NONWASTEWATERS	1-6
1-2	PROPOSED BDAT TREATMENT STANDARDS FOR K083 WASTEWATERS	1-7
2-1	POTENTIAL GENERATORS OF K083	2-4
2-2	K083 CHARACTERIZATION DATA	2-5
4-1	WASTES TESTED BY INCINERATION AND SAMPLED BY EPA	4-8
4-2	WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR K019 AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION	4-9
4-3	TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019 AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION	4-13
4-4	TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019 AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION	4-14
4-5	DESIGN AND OPERATING DATA FOR THE ROTARY KILN AND SECONDARY COMBUSTOR	4-15
4-6	TCLP ANALYTICAL RESULTS FOR THE F024 ROTARY KILN INCINERATOR ASH SAMPLES	4-16
4-7	TEST CONDITIONS COMMON TO ALL BATCHES OF STABILIZED F024 INCINERATION ASH	4-17
4-8	TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR TREATMENT OF K062 BY CHEMICAL PRECIPITATION FOLLOWED BY VACUUM FILTRATION	4-18
6-1	STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083	6-6
6-2	BDAT LIST CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN K083 NONWASTEWATERS AND WASTEWATERS	6-13
7-1	CALCULATION OF TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 NONWASTEWATERS	7-10
7-2	CALCULATION OF TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 WASTEWATERS	7-11

LIST OF FIGURES

Figure		Page
2-1	SIMPLIFIED FLOW DIAGRAM FOR THE PRODUCTION OF ANILINE BY VAPOR-PHASE HYDROGENATION OF NITROBENZENE	2-6
2-2	SIMPLIFIED FLOW DIAGRAM FOR THE PRODUCTION OF ANILINE BY LIQUID-PHASE HYDROGENATION OF NITROBENZENE	2-7
2-3	SIMPLIFIED FLOW DIAGRAM FOR THE PRODUCTION OF ANILINE BY THE IRON REDUCTION OF NITROBENZENE (THE BECHAMP PROCESS)	2-8
2-4	SIMPLIFIED FLOW DIAGRAM FOR THE PRODUCTION OF ANILINE BY VAPOR-PHASE AMMONOLYSIS OF PHENOL	2-9

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA or Agency) is proposing to establish best demonstrated available technology (BDAT) treatment standards for the listed hazardous waste identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as K083, distillation bottoms from the production of aniline. These BDAT treatment standards are being established in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984. BDAT treatment standards will be effective no later than May 8, 1990, and on or after the effective date, compliance with these BDAT treatment standards will be a prerequisite under 40 CFR Part 268 for placement of the waste in land disposal units.

This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K083 and for developing treatment standards for these constituents. The document also provides waste characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K083 that is more difficult to treat than the wastes that were analyzed in developing treatment standards for K083.

The Agency's legal authority and promulgated methodology for establishing treatment standards and the petition process necessary for requesting a variance from the treatment standards are summarized in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1).

This background document presents waste-specific information on the number and locations of facilities that may be affected by the land disposal restrictions for K083, the processes generating this waste, the waste characterization data, the technologies used to treat the waste (or similar wastes, if any), and the treatment performance data on which the proposed treatment standards are based (Sections 2.0 - 4.0). This document also explains how EPA determines BDAT, selects constituents to be regulated, and calculates treatment standards (Sections 5.0 - 7.0).

Under 40 CFR 261.32, wastes identified as K083 are listed as follows:

K083 - Distillation bottoms from aniline production.

The four-digit Standard Industrial Classification (SIC) code associated with the production of nitrobenzene is 2865. The Agency estimates that there are six domestic facilities that may generate K083.

The Agency is proposing to revise the "No Land Disposal Based on No Generation" treatment standard that was published for nonwastewater forms of K083 on August 17, 1988 and is proposing treatment standards for wastewater forms of K083, which have been subject to the "soft hammer" provisions of Section 3004(g)(6) of RCRA. The "No Land Disposal" standard for K083 nonwastewaters (containing <0.01% by weight ash) was based on the premise that current waste treatment processes do not generate residuals requiring land disposal. The Agency believes that this standard should be revised for

several reasons: (1) a facility intending to manufacture aniline in the future using a process that generates distillation bottoms as a result, would be forced to apply for a variance from the treatment standard (40 CFR 268.44); (2) a facility disposing of K083 from past aniline manufacturing operations as part of a corrective action would also be forced to apply for a variance from the treatment standard; and (3) a facility changing its treatment process from one that did not generate treatment residuals to one that may generate residuals would be forced to apply for a variance from the treatment standard.

The Agency is proposing seven organic constituents and one metal constituent for regulation in nonwastewater and wastewater forms of K083. To determine the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1% (weight basis) total suspended solids[1] (TSS) and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters and must comply with nonwastewater treatment standards.

The Agency does not have any performance data on the treatment of K083. Treatment performance tests for this waste have not been pursued because the Agency believes that adequate treatment performance data are

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[1]The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids". Specifically, total suspended solids is measured by Method 209C (total suspended solids dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition (Reference 2).

available from similar wastes previously tested by the BDAT Land Disposal Restrictions Program. Therefore, treatment performance data were transferred to K083 from other previously tested wastes.

For organic constituents in nonwastewater and wastewater forms of K083, proposed BDAT treatment standards are based on treatment performance data transferred from incineration of RCRA Blend waste that was co-treated with K019 (Reference 3).

For metal constituents in nonwastewater forms of K083, proposed BDAT treatment standards are based on treatment performance data transferred from stabilization of F024 incinerator ash.

For metal constituents in wastewater forms of K083, proposed BDAT treatment standards are based on treatment performance data transferred from chemical precipitation followed by vacuum filtration of K062.

Tables 1-1 and 1-2 at the end of this section list the proposed BDAT treatment standards for nonwastewater and wastewater forms of K083. These proposed treatment standards are based on the total concentration of each constituent in the waste. The units used for total constituent concentration of organic constituents are mg/kg (parts per million on a weight-by-weight basis) for K083 nonwastewaters, and mg/l (parts per million on a weight-by-volume basis) for K083 wastewaters. If the concentrations of the constituents proposed for regulation in K083 nonwastewaters and wastewaters, as generated,

are lower than or equal to the proposed treatment standards, then treatment of the waste would not be required prior to "land disposal," as defined by 40 CFR Part 268.

Table 1-1

PROPOSED BDAT TREATMENT STANDARDS FOR K083

NONWASTEWATERS

Maximum for Any Single Grab Sample	
BDAT List Constituent	Total Concentration (mg/kg)
4. Benzene	6.6
56. Aniline	14
106./219. Diphenylamine/ Diphenylnitrosamine	14[a]
126. Nitrobenzene	14
142. Phenol	5.6
232. Cyclohexanone	30
BDAT List Constituent	TCLP Leachate Concentration (mg/l)
163. Nickel	0.088

[a]This value represents the sum of the diphenylamine and diphenylnitrosamine concentrations.

Table 1-2

PROPOSED BDAT TREATMENT STANDARDS FOR K083

WASTEWATERS

Maximum for Any Single Grab Sample	
BDAT List Constituent	Total Concentration (mg/L)
4. Benzene	0.008
56. Aniline	0.017
106./219. Diphenylamine/ Diphenylnitrosamine	0.017[a]
126. Nitrobenzene	0.017
142. Phenol	0.007
232. Cyclohexanone	0.036
163. Nickel	0.47

[a]This value represents the sum of the diphenylamine and diphenylnitrosamine concentrations.

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

This section describes the industries that may be affected by the land disposal restrictions for K083, the processes generating the waste, and available waste characterization data. All tables and figures are presented at the end of this section.

2.1 Industry Affected and Process Description

Under 40 CFR Part 261.32, K083 is defined as distillation bottoms from the production of aniline. The Agency estimates that there are approximately six potential generators of K083, which are identified by location and EPA region in Table 2-1.

There are several commercial processes used for the production of aniline including vapor- or liquid-phase hydrogenation of nitrobenzene, iron reduction of nitrobenzene, and vapor-phase ammonolysis of phenol. Vapor-phase hydrogenation of nitrobenzene is the most widely used method in the United States.

Vapor-Phase Hydrogenation of Nitrobenzene

As illustrated in Figure 2-1 and described step-by-step below, nitrobenzene is vaporized in a stream of hydrogen and fed to the reactor, where it is reduced to aniline in the presence of a catalyst (copper, nickel,

vanadium, or cobalt). The reaction products are condensed, and the unreacted hydrogen is recycled. The condensed product stream is sent to a separator. The upper layer is pumped to an aniline extractor. The lower layer is purified in a two-step distillation process into the aniline product. The heavy ends or distillation bottoms from the refined aniline column constitute the waste of concern, K083.

Liquid-Phase Hydrogenation of Nitrobenzene

The liquid-phase process as shown in Figure 2-2 uses a catalyst suspended in liquid nitrobenzene and liquid hydrogen to produce aniline. Aniline is then purified by distillation. Bottoms from distillation comprise the listed waste K083.

Iron Reduction of Nitrobenzene

The Bechamp process, as illustrated in Figure 2-3, reduces nitrobenzene in the presence of iron fillings with ferrous chloride solution to produce aniline. The product stream is neutralized with lime and sent to a separator. The organic phase containing aniline is withdrawn while the remaining separator solution is sent to residual aniline recovery and iron oxide production. The organic phase is sent to a stripper where water is removed. A final distillation produces aniline. The distillation bottoms constitute K083.

Vapor-Phase Ammonolysis of Phenol

Vapor-phase ammonolysis of phenol to produce aniline is illustrated in Figure 2-4. Phenol and ammonia are vaporized and combined in a reactor with a silica-alumina catalyst. The reaction products are passed through a distillation column where ammonia is recovered and recycled and water is removed. The organic stream from the distillation column is sent to a drying column where additional water is removed. Product aniline and phenol (to recycle) are removed from a final finishing column. Distillation bottoms from the finishing column comprise the listed waste K083.

2.2 Waste Characterization

Available data sources (References 4, 5, 6, 7) indicate the following general composition for K083:

Constituent	Concentration (%)
Aniline	35
Other organics	46
Inorganics	1
Solids	15
Oils	2
Water	1
Total:	100%

Specific waste characterization data are presented in Table 2-2. These data represent K083 generated by three different processes:

- the Bechamp process (K083-1);
- liquid-phase hydrogenation of nitrobenzene (K083-2); and
- vapor-phase hydrogenation of nitrobenzene (K083-3 and K083-4).

Table 2-1

POTENTIAL GENERATORS OF K083

Facility	Location	EPA Region
Aristech Chemical Corp.	Haverhill, OH	V
E.I. duPont de Nemours	Beaumont, TX	VI
First Chemical Corp.	Pascagoula, MS	IV
Mallinckrodt, Inc.	Raleigh, NC	IV
Mobay Chemicals	New Martinsville, WV	III
Rubicon, Inc.	Geismar, LA	VI

Source: Directory of Chemical Producers, United States of America. (Reference 8).

Table 2-2

K083 CHARACTERIZATION DATA

BDAT List Constituent	Concentration in Untreated Waste (ppm) K083-1	K083-2	K083-3	K083-4
56. Aniline (ppm)	301,000-550,000	40,000	200,000-400,000	387,000
4. Benzene (ppm)	-	-	58,000	2,000
232. Cyclohexanone (ppm)	-	-	-	2,000
106. Diphenylamine (ppm)	-	-	1,700	-
126. Nitrobenzene (ppm)	1,000-1,900	-	-	10,000
142. Phenol (ppm)	-	-	-	35,000
160. Copper (ppm)	-	2.5	-	-
161. Lead (ppm)	1.9-3.0	-	-	-
163. Nickel (ppm)	345	-	-	-
171. Sulfide (ppm)	-	21,000	-	-
Condensation by-products (%)	40.0-65.0	-	-	-
Non-volatiles (%)	32.24-66.04	-	-	-
Oils (%)	0.0-5.0	-	-	-
Other Heavy Organics (%)	-	-	20-40	-
Ash (%)	7.0-24.0	<0.01	-	-
Carbon (%)	-	71.6	-	-
Total Organic Carbon (%)	-	72.3	-	-
Hydrolyzed Chlorides (%)	2.03	<0.001	-	-
Total Chlorides (%)	1.0-7.0	0.3	-	-
Total Organic Halides (%)	-	0.185	-	-
Hydrogen (%)	-	6.2	-	-
Nitrogen (%)	4.52	11.5	-	-
Oxygen (%)	-	11.5	-	-
Suspended Solids (%)	14.0-22.9	-	18	-
Water (%)	0.5-2.0	<0.01	-	-
Unknown (%)	2.11	-	-	-
Acidity (as HCl, %)	5.14	-	-	-
Basicity (as NaOH, %)	0.101-0.73	-	-	-
Flash Point (F)	158	-	-	-
Heat Value (Btu/lb)	13,000-16,000	13,000	-	-
Specific Gravity @ 25 C	1.06-1.33	-	-	-
Viscosity (cps @ 25 C)	400-14,000	-	-	-

Note: K083-1 represents K083 generated by the Bechamp process,
K083-2 represents K083 generated by liquid-phase hydrogenation of nitrobenzene, and
K083-3 and K083-4 represent K083 generated by vapor-phase hydrogenation of nitrobenzene.

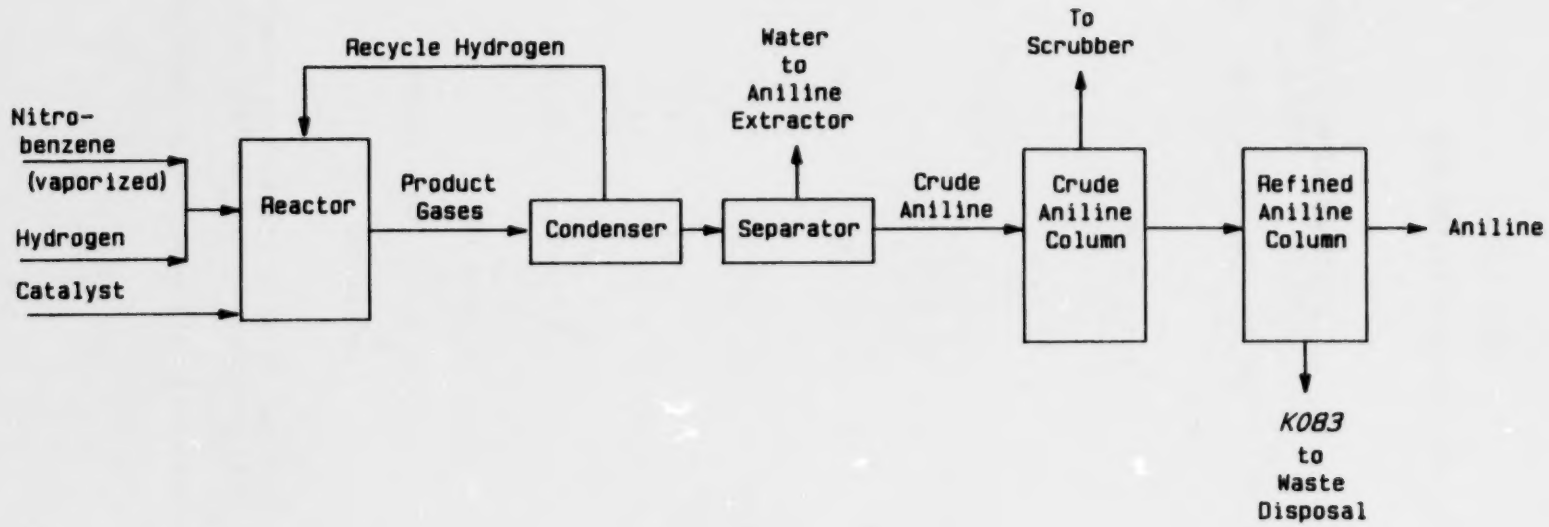

Figure 2-1. Simplified Flow Diagram for the Production of Aniline by Vapor-Phase Hydrogenation of Nitrobenzene

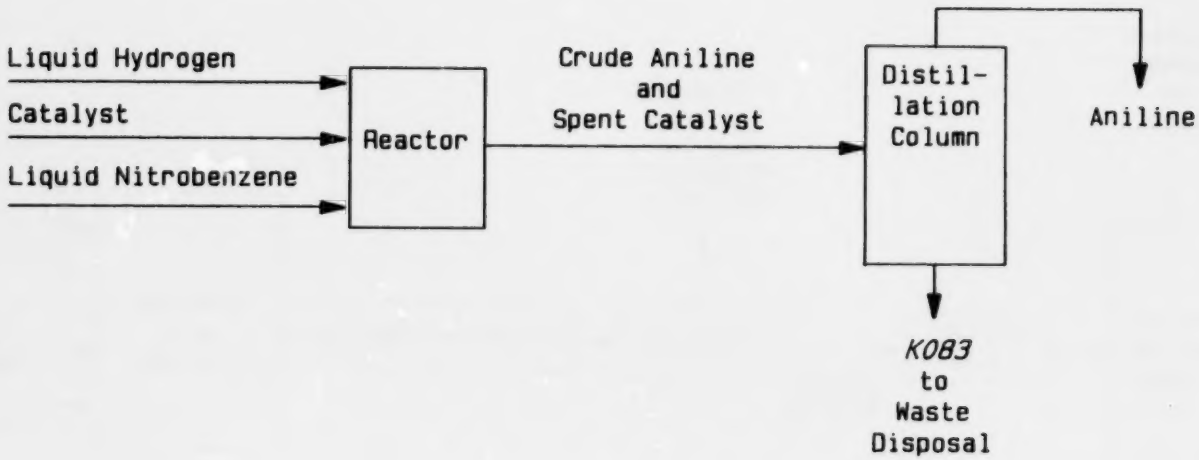

Figure 2-2. Simplified Flow Diagram for the Production of Aniline by Liquid-Phase Hydrogenation of Nitrobenzene

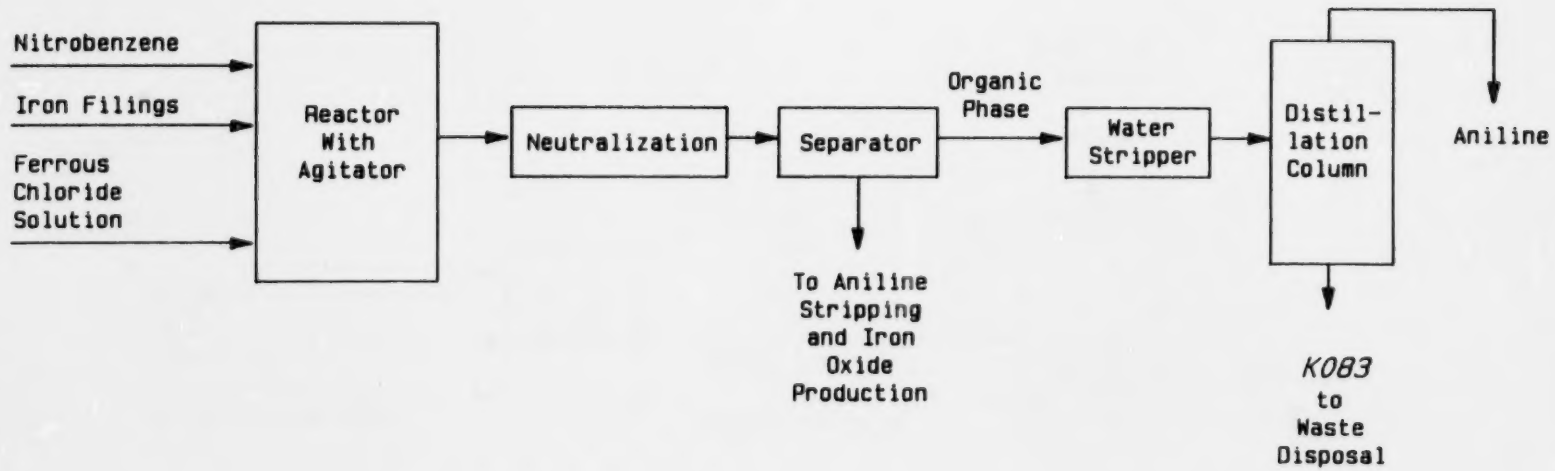

Figure 2-3. Simplified Flow Diagram for the Production of Aniline by the Iron Reduction of Nitrobenzene (the Bechamp process)

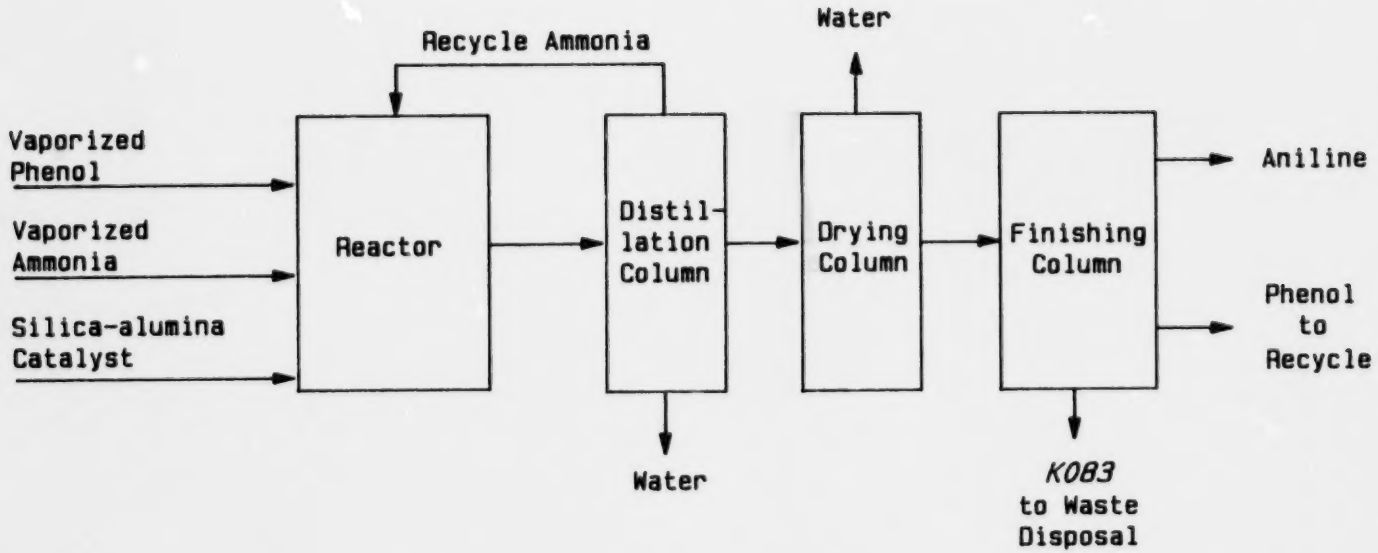

Figure 2-4. Simplified Flow Diagram for the Production of Aniline by Vapor-Phase Ammonolysis of Phenol

3.0 APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

This section discusses the technologies that are applicable to treatment of K083 nonwastewaters and wastewaters and determines which, if any, of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT.

To be applicable, a technology must theoretically be usable to treat the waste in question or a waste that is similar in terms of parameters that affect treatment selection. (Detailed descriptions of technologies that are applicable to listed hazardous wastes are provided in EPA's Treatment Technology Background Document (Reference 9).) To be demonstrated, a technology must be employed in full-scale operation for treatment of the waste in question or a similar waste. Technologies available only at pilot- or bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

The following subsections present applicable treatment technologies for nonwastewater and wastewater forms of K083.

Nonwastewaters

Since nonwastewater forms of K083 consist primarily of organic compounds (as shown in Section 2.0 of this document), applicable treatment

technologies include those that destroy or reduce the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as potentially applicable for these wastes: (1) incineration (fluidized bed and rotary kiln) followed by stabilization of incinerator ash; (2) solvent extraction followed by incineration or recycle of the extract; and (3) critical fluid extraction followed by recycle or incineration of the contaminated solvents. These treatment technologies were identified based on current waste treatment practices and engineering judgment.

Incineration. Incineration is a destruction technology in which energy, in the form of heat, is transferred to the waste to destabilize chemical bonds and destroy organic constituents. In a fluidized bed incinerator, waste is injected into the fluidized bed material (generally sand and/or incinerator ash), where it is heated to its ignition temperature. Heat energy from the combustion reactions is then transferred back to the fluidized bed. Ash is removed periodically during operation and during bed change-outs.

In a rotary kiln incinerator, wastes are fed into the elevated end of the kiln, and the rotation of the kiln mixes the waste with hot gases to heat the waste to its ignition temperature. Ash is removed from the lower end of the kiln. Combustion gases from the kiln enter the afterburner for complete destruction of organic waste constituents. Other wastes may also be injected into the afterburner.

Combustion gases from the fluidized bed or kiln afterburner are then fed to a scrubber system for cooling and removal of entrained particulates and acid gases, if present. In general, two residuals are generated by incineration processes: ash and scrubber water. Metals and other inorganic constituents in incinerator ash can be treated using stabilization. Metals and other inorganic constituents in scrubber water can be treated using chemical precipitation and vacuum filtration.

Stabilization. Stabilization refers to a broad class of treatment processes that physically or chemically reduce the mobility of metal constituents in a waste by binding these constituents into a solid material that is resistant to leaching.

Solvent Extraction. Solvent extraction is a separation technology in which organics are removed from the waste due to greater constituent solubility in the solvent phase than in the waste phase. This technology results in the generation of two treatment residuals: a treated waste residual and an extract. Metals and other inorganic constituents in the treated waste residual can be treated by stabilization. The extract may be recycled or further treated by incineration.

Critical Fluid Extraction. Critical fluid extraction is a solvent extraction technology in which the solvent is brought to its critical state to aid in the extraction of organic constituents from the wastes. After the extraction step, the solvent (liquefied gas at its critical state) is brought

to its normal condition in the gaseous state and generates a small volume of extract that is concentrated in hazardous organic constituents. This technology results in the generation of two treatment residuals: a treated waste and an extract. The extract may be recycled or further treated by incineration.

Wastewaters

Since wastewater forms of K083 may contain organic constituents at treatable concentrations, applicable technologies include those that destroy or reduce the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as potentially applicable for treatment of K035 wastewaters: (1) incineration followed by chemical precipitation and vacuum filtration of scrubber water; (2) steam stripping; (3) biological treatment; (4) carbon adsorption; (5) solvent extraction; and (6) wet air oxidation.

Incineration. Incineration of wastewaters in a rotary kiln or fluidized bed is identical to that for nonwastewaters described previously in this section. In addition, liquid injection incineration may also be applicable to K083 wastewaters.

In a liquid injection incinerator, liquid wastes are atomized and injected into the incinerator. Combustion gases from the incinerator are then fed to a scrubber system for cooling and removal of entrained particulates and acid gases, if present. In general, only wastes with low or negligible ash

content are amenable to liquid injection incineration. Therefore, this technology generally does not result in the generation of an ash residual.

Chemical Precipitation and Vacuum Filtration. Chemical precipitation and vacuum filtration are separation technologies in which metals are precipitated and removed from wastewaters. These technologies result in the generation of two treatment residuals: a treated wastewater and a precipitate. The precipitate may require further treatment by stabilization.

Steam Stripping. Steam stripping is a separation technology in which volatile organics are removed from the waste by volatilization through the application of heat. This technology results in the formation of two treatment residuals: a treated waste extract and a treated effluent. The treated waste extract and the treated effluent may require further treatment by incineration, and carbon adsorption or biological treatment, respectively.

Biological Treatment. Biological treatment is a destruction technology in which organic constituents in wastewaters are biodegraded. This technology results in the formation of two treatment residuals: a treated effluent and a waste biosludge. The treated effluent and the waste biosludge may require further treatment for metals by chemical precipitation and stabilization, respectively.

Carbon Adsorption. Carbon adsorption is a separation technology in which organic constituents in wastewaters are selectively adsorbed onto

activated carbon. This technology results in the formation of two treatment residuals: a treated effluent and spent activated carbon. The treated effluent may require further treatment for metals by chemical precipitation. The spent carbon may require further treatment by incineration.

Solvent Extraction. Solvent extraction of wastewaters is identical to that for nonwastewaters described previously in this subsection.

Wet Air Oxidation. Wet air oxidation is a destruction technology in which organic constituents in wastes are oxidized and destroyed under pressure at elevated temperatures in the presence of dissolved oxygen. This technology is applicable for wastes comprised primarily of water and up to 10% total organic concentration (TOC). Wet air oxidation results in the formation of one treatment residual: treated effluent. The treated effluent may require further treatment for organic constituents by carbon adsorption or PACT^{R} treatment, as described in this subsection. Emissions from wet air oxidation may require further treatment by incineration.

PACT^{R} Treatment. PACT^{R} treatment is the addition of powdered activated carbon to a biological treatment process. This technology results in the formation of two treatment residuals: a treated effluent and a waste biosludge. The treated effluent and the waste biosludge may require further treatment for metals by chemical precipitation and stabilization, respectively. In addition, the waste biosludge may require further treatment by incineration.

3.2 Demonstrated Treatment Technologies

The Agency is aware of four facilities that incinerate K083 nonwastewaters and two facilities that burn K083 nonwastewaters as fuel. In addition, the Agency tested rotary kiln incineration for similar wastes, as discussed in Section 4.0 of this document.

EPA is not aware of any facilities that treat metal constituents in nonwastewater forms of K083 by stabilization. However, stabilization is demonstrated for metal constituents in wastes judged to be similar, such as F024, as discussed in Section 4.0 of this document.

EPA is not aware of any facilities that treat organic constituents in wastewater forms of K083. However, incineration is demonstrated for organic constituents in wastes judged to be similar, as discussed in Section 4.0 of this document.

EPA is not aware of any facilities that treat metal constituents in K083 wastewaters. However, chemical precipitation followed by vacuum filtration is demonstrated for metal constituents in similar wastes, such as K062, as discussed in Section 4.0 of this document.

The Agency is not aware of any other technologies that are demonstrated for treatment of K083.

4.0 TREATMENT PERFORMANCE DATA BASE

This section presents the treatment performance data that were used to develop proposed treatment standards for nonwastewater and wastewater forms of K083.

Where data are not available on the treatment of the specific waste of concern, the Agency may elect to transfer performance data from a demonstrated technology that treats a similar waste or wastes. EPA's methodology for the transfer of treatment performance data is provided in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1). Transfer of treatment performance data is technically valid in cases where the untested wastes are generated from similar industries or similar processing steps, or have similar waste characteristics affecting treatment selection and performance that are similar to those of the tested wastes.

The Agency does not have any treatment performance data for treatment of K083 nonwastewaters or wastewaters. However, treatment performance data were available from other wastes previously tested by EPA and were transferred to develop proposed treatment standards for K083. Sources of treatment performance data for potential transfer to K083 include wastes previously tested by incineration (including rotary kiln and fluidized bed) followed by stabilization of incinerator ash and chemical precipitation and vacuum filtration of scrubber water. These technologies were identified as

applicable and demonstrated for treatment of these wastes, as discussed in Section 3.0 of this document.

4.1 Organic Constituents

Previous incineration tests conducted by the Agency are listed in Table 4-1 at the end of this section. EPA examined the wastes incinerated in these tests to identify the best data source(s), if any, for transfer of treatment performance data to K083 nonwastewaters and wastewaters. Specifically, EPA examined (1) whether the untested K083 is generated from a similar industry or processing step and (2) whether the waste has similar waste characteristics as those previously tested wastes.

Wastes included in Tests 3, 4, 5, 11, 12, 13, and 14 are generated by the organic chemicals industry. Like K083, wastes incinerated in Tests 3, 4, 5, 11, and 14 were generated by distillation or some other type of separation process.

Of the wastes generated by a process similar to that generating K083, those incinerated in Tests 3, 4, and 14 contain nitrogenated compounds and are, therefore, most structurally similar to K083. The wastes incinerated in these tests are also similar to K083 in that they are all organic wastes. The waste incinerated in Test 3 has a high concentration of water, while the water content of K083 and the wastes incinerated in Tests 4 and 14 is quite low. The constituents in the RCRA Blend waste incinerated in Test 4 are more

similar to K083 than those in Tests 3 and 14 with respect to structure and physical properties that affect the treatment performance of incineration, such as boiling points and bond dissociation energies. In addition, the RCRA Blend waste incinerated in Test 4 is expected to have a similar thermal conductivity to K083. Therefore, treatment performance similar to that achieved for RCRA Blend waste could be achieved for K083.

Based on the similarities discussed above, treatment standards for organic constituents being proposed for regulation in K083 nonwastewaters and wastewaters were developed based on treatment performance data transferred from rotary kiln incineration of the RCRA Blend waste that was co-incinerated with K019 in Test 4.

K019 and three other wastes, referred to as "RCRA Blend", "PCB Blend", and "mercaptan-contaminated waste," were treated in Test 4. K019, RCRA Blend waste, PCB Blend waste, and mercaptan-contaminated waste comprised approximately 20%, 23%, 41%, and 16%, respectively, of the waste treated. K019 and RCRA Blend were fed to the rotary kiln; PCB Blend and mercaptan-contaminated waste were fed to the afterburner (secondary combustor). The ash generated from rotary kiln incineration results from treatment of the K019 and RCRA Blend wastes only, while scrubber water results from treatment of all four of the wastes fed to the incinerator. The ash data from the incineration of K019 and RCRA Blend wastes were transferred to K083 nonwastewaters, and the scrubber water data from incineration of all four wastes were transferred to K083 wastewaters. Tables 4-2 and 4-3 present the BDAT List constituents

detected in the untreated wastes and in the kiln ash residual for six sample sets collected by EPA from the rotary kiln incineration treatment system. Table 4-4 presents BDAT List constituents detected in the scrubber water residual for six sample sets collected by EPA from the same incineration system. Design and operating data are presented in Table 4-5 for each sample set. All tables are presented at the end of this section.

4.2 Metal Constituents

This subsection discusses the performance data from treatment of metal constituents in nonwastewater and wastewater forms of K083.

Nonwastewater

The Agency examined all of the available nonwastewater treatment performance data for metal constituents. Treatment of F024 incinerator ash by stabilization was the sole source of data for the constituent of concern. EPA examined the F024 ash stabilization data to evaluate whether transferring these treatment performance data to K083 nonwastewater metals was appropriate. Specifically, EPA examined whether the untested K083 is (1) generated from a similar industry or processing step and (2) whether the waste has similar waste characteristics affecting treatment performance as does the previously tested waste.

Both K083 and F024 are generated by the organic chemicals industry. They are also both generated by some type of separation process.

After determining that the wastes are generated by similar industries and processes, EPA examined the relative treatability of metal constituents in K083 nonwastewater and in F024 nonwastewater. As discussed in the Treatment Technology Background Document (Reference 9), waste characteristics that affect the performance of stabilization are the concentrations of the following parameters: fine particulates, oil and grease, organic compounds, sulfate, and chloride compounds.

K083 and F024 are expected to have similar concentrations of these parameters. F024 is also expected to have a similar or higher concentration of the constituent of concern, nickel, than K083. Because of these similarities, the wastes are believed to be similar and are expected to be treated to similar concentrations by stabilization of incinerator ash.

Based on these analyses, transfer of treatment performance data from stabilization of F024 nonwastewater metals to K083 nonwastewater metals is valid. Treatment performance data for stabilization of F024 incinerator ash are included in Table 4-6 and associated design and operating data are in Table 4-7.

Wastewater

EPA's database for chemical precipitation in wastewaters is included in the California List Notice of Data Availability (Reference 11). Data are available for chemical precipitation and vacuum filtration of K062 mixed with metal-bearing characteristic hazardous wastes (Reference 12). Data are also available for chromium reduction followed by lime and sulfide precipitation and vacuum filtration for K062 mixed with metal-bearing characteristic hazardous wastes. However, since K083 is not known to contain hexavalent chromium, and therefore hexavalent chromium treatment is not necessary, the data for chromium reduction followed by lime and sulfide precipitation and vacuum filtration were not considered. EPA screened the available data to determine whether any wastes are generated from similar industries or similar processing steps, or have similar waste characteristics as those expected for scrubber water generated from the incineration of K083. The metal constituent of concern in K083 is nickel, as shown by the waste characterization data included in the Final BDAT Background Document for K083. Based on waste characterization data, the K062 mixed with metal-bearing characteristic hazardous wastes and K083 scrubber water are expected to contain nickel at similar concentrations.

EPA then examined the relative treatability of K083 scrubber water and the mixture of K062 and metal-bearing characteristic hazardous wastes. As discussed in the Technology Treatment Background Document (Reference 9), waste characteristics that affect treatment performance for chemical precipitation

include the concentration and types of metals in the waste, the concentrations of dissolved solids in the waste, the oil and grease content of the waste, and whether the metals exist in the wastewater as a complex. EPA considers K062 wastewaters to be more difficult to treat than K083 wastewaters because equal or higher concentrations of metals and dissolved solids are anticipated in K062 than in scrubber water from incineration of K083. These higher concentrations of metals and dissolved solids would interfere with the effectiveness of the precipitation reactions intended to remove the metals of concern. Since K083 scrubber water is generated from incineration, oil and grease is also not considered to be significant. However, the K062 mixture contains oil and grease and may therefore be more difficult to treat than K083 scrubber water. Complex metals are not considered to be significant parameters in either waste. Based on consideration of these points, the mixture of K062 and metal-bearing characteristic hazardous wastes is considered to be more difficult to treat than wastewater forms of K083.

Based on these analyses, transfer of treatment performance data from chemical precipitation and vacuum filtration of K062 mixed with metal-bearing characteristic hazardous wastes to K083 wastewaters was judged to be valid. Treatment performance data for lime and sulfide precipitation followed by filtration from K062 mixed with metal-bearing characteristic hazardous wastes are included in Table 4-8.

Table 4-1

WASTES TESTED BY INCINERATION AND SAMPLED BY EPA

Test Number	Waste Code(s)	Treatment Technology Used
1	K001 - Pentachlorophenol waste	Rotary kiln incineration
2	K001 - Creosote waste	Rotary kiln incineration
3	K011, K013, K014	Rotary kiln incineration
4	K019	Rotary kiln incineration
5	K024	Rotary kiln incineration
6	K037	Rotary kiln incineration
7	K048, K051	Fluidized bed incineration
8	K087	Rotary kiln incineration
9	K101	Rotary kiln incineration
10	K102	Rotary kiln incineration
11	F024	Rotary kiln incineration
12	K015	Liquid injection incineration
13	D014, D016, P059*, U127*, and U192*	Rotary kiln incineration
14	U141*, U028*, P020*, U112*, U226*, U239*, U080*, U220*, U166*, U161*, and U188*	Rotary kiln incineration

*Commercial chemical products were used in these test burns as surrogates for these wastes.

Table 4-2

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Wastes fed to the Rotary Kiln[a]		Wastes fed to the Secondary Combustor	
	K019 (ppm)	RCRA Blend (ppm)	PCB Blend (ppm)	Mercaptan-Contaminated Waste (ppm)
VOLATILES				
4. Benzene	<2,000	2,000	2,000	17.0
7. Carbon tetrachloride	3,500-4,100	<8	<2,000	1.9
9. Chlorobenzene	<2,000-3,000	<8	<2,000	<0.4
14. Chloroform	4,600-6,000	<8	<2,000	<0.4
22. 1,1-Dichloroethane	<2,000-2,200	<8	<2,000	<0.4
23. 1,2-Dichloroethane	87,000-130,000	<8	<2,000	<0.4
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5
38. Methylene chloride	<10,000	910	<10,000	<2.0
42. Tetrachloroethene	6,000-7,800	490	<2,000	<0.4
43. Toluene	<2,000	2,300	41,000	3.7
45. 1,1,1-Trichloroethane	33,000-81,000	130	<2,000	2.3
47. Trichloroethene	2,200-3,210	360	3,600	<0.4
215-217. Xylene (total)	<2,000	3,400	36,000	4.4
222. Acetone	<10,000	1,200	<10,000	<2.0
226. Ethyl benzene	<2,000	2,200	16,000	4.1
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0

[a] Six sample sets of K019 were collected; results are presented as ranges, where appropriate. One sample of RCRA Blend, PCB Blend, and Mercaptan-Contaminated wastes were collected.

Note: This table shows the concentrations in the untreated waste for all constituents that were detected in the untreated waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-2 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Wastes fed to the Rotary Kiln[a]		Wastes fed to the Secondary Combustor	
	K019 (ppm)	RCRA Blend (ppm)	PCB Blend (ppm)	Mercaptan-Contaminated Waste (ppm)
SEMIVOLATILES				
51. Acenaphthalene	<10	150	120	<0.002
52. Acenaphthene	<10	<20	480	<0.002
56. Aniline	<25	<50	<250	1.220
57. Anthracene	<10	110	400	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002
68. Bis(2-chloroethyl)ether	280-340	<20	<100	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079
80. Chrysene	SNA	28	<100	<0.002
81. ortho-Cresol	<10	<20	<100	0.020
87. o-Dichlorobenzene	<10	250	1,060	2.550
88. p-Dichlorobenzene	74-90	32	460	0.260
90. 2,4-Dichlorophenol	<25	<50	<250	0.420
91. 2,6-Dichlorophenol	<25	<50	500	0.430
98. Di-n-butyl phthalate	<10	31	120	0.012
104. Di-n-octyl phthalate	<10	<20	430	<0.002
108. Fluoranthene	<10	120	300	<0.002
109. Fluorene	16-22	53	340	<0.002
110. Hexachlorobenzene	60-87	<100	<500	0.002
111. Hexachlorobutadiene	<50	210	<500	0.079
113. Hexachloroethane	85-120	<100	<500	0.018

[a] Six sample sets of K019 were collected; results are presented as ranges, where appropriate. One sample of RCRA Blend, PCB Blend, and Mercaptan-Contaminated wastes were collected.

Note: This table shows the concentrations in the untreated waste for all constituents that were detected in the untreated waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-2 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Wastes fed to the Rotary Kiln[a] K019 (ppm)	Wastes fed to the Rotary Kiln[a] RCRA Blend (ppm)	Wastes fed to the Secondary Combustor[a] PCB Blend (ppm)	Wastes fed to the Secondary Combustor[a] Mercaptan-Contaminated Waste (ppm)
SEMIVOLATILES (Continued)				
121. Naphthalene	314-470	<20	400	0.133
122. 1,4-Naphthoquinone	<10	<20	<100	0.078
126. Nitrobenzene	<25	3,400	8,200	0.027
136. Pentachlorobenzene	51-65	<100	1,000	0.020
141. Phenanthrene	11-21	240	950	<0.002
142. Phenol	<10	78	1,000	4.56
145. Pyrene	<10	200	260	<0.002
148. 1,2,4,5-Tetrachlorobenzene	62-86	<50	1,400	0.008
150. 1,2,4-Trichlorobenzene	65-100	<50	19,000	1.24
152. 2,4,5-Trichlorophenol	<50	<100	<500	0.037
METALS				
155. Arsenic	<0.2-1.2	94	7.4	<0.02
156. Barium	<0.9-0.97	1.3	<19	1.67
158. Cadmium	<0.3-0.63	<0.3	<33	<0.003
159. Chromium	1.8-5.3	40	23.7	<0.009

[a] Six sample sets of K019 were collected; results are presented as ranges, where appropriate. One sample of RCRA Blend, PCB Blend, and Mercaptan-Contaminated wastes were collected.

Note: This table shows the concentrations in the untreated waste for all constituents that were detected in the untreated waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-2 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Wastes fed to the Rotary Kiln[a]		Wastes fed to the Secondary Combustor	
	K019 (ppm)	RCRA Blend (ppm)	PCB Blend (ppm)	Mercaptan-Contaminated Waste (ppm)
METALS (Continued)				
160. Copper	<1.0-3.6	23.7	107	0.027
161. Lead	2.1-3.5	165	<7.3	0.0064
163. Nickel	2.2-6.0	27	6.2	0.037
168. Zinc	4.4-9.4	8.8	6810	0.071
		4,170		
INORGANICS				
171. Sulfide	790	830	16,000	17

[a] Six sample sets of K019 were collected; results are presented as ranges, where appropriate. One sample of RCRA Blend, PCB Blend, and Mercaptan-Contaminated wastes were collected.

Note: This table shows the concentrations in the untreated waste for all constituents that were detected in the untreated waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-3

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

KILN ASH RESIDUAL

BDAT List Constituent	DETECTION LIMIT	SAMPLE SET #1	SAMPLE SET #2	SAMPLE SET #3	SAMPLE SET #4	SAMPLE SET #5	SAMPLE SET #6
		Concentration in Kiln Ash - Total Concentration (mg/kg)					
SEMIVOLATILES							
70. Bis(2-ethylhexyl)phthalate	2	ND	ND	ND	12	ND	ND
72. Di-n-butyl phthalate	2	ND	ND	ND	230	ND	ND
METALS							
154. Antimony	6.0	8.0	6.8	9.2	ND	9.1	9.6
155. Arsenic	0.2	3.6	2.8	5.7	5.7	3.9	2.3
156. Barium	0.9	26	23	54	8.4	21	11
158. Cadmium	0.3	0.66	0.96	3.6	ND	1.2	2.2
159. Chromium	0.9	44	60	202	28	125	141
160. Copper	1.0	2370	3430	2290	1270	2780	2520
161. Lead	0.2	120	42	118	25	86	34
163. Nickel	2.0	66	89	169	69	166	288
165. Silver	0.9	3.3	3.4	1.9	2.6	3.3	3.1
167. Vanadium	2.0	4.1	4.8	6.0	ND	5.7	8.7
168. Zinc	0.6	12	13	16	11	22	13
INORGANICS							
170. Fluoride	2	38	ND	6.1	3.2	23	4.7
171. Sulfide	50	68	5.1	64	ND	64	92

ND - The compound was not quantified at or above the detection limit.

Note: This table shows the concentrations in the kiln ash for all constituents that were detected in the nonwastewater residuals generated from treatment of the waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-4

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

SCRUBBER WATER RESIDUAL

BDAT List Constituent	DETECTION LIMIT	SAMPLE SET #1	SAMPLE SET #2	SAMPLE SET #3	SAMPLE SET #4	SAMPLE SET #5	SAMPLE SET #6
		Concentration in Scrubber Water - Total Concentration (ug/l)					
VOLATILES							
21. Dichlorodifluoromethane	2	ND	ND	4.3	14	ND	ND
43. Toluene	2	ND	3.2	2.6	4.6	ND	ND
SEMIVOLATILES							
98. Di-n-butyl phthalate	2	ND	6.3	4.6	4.2	2.7	2.5
METALS							
154. Antimony	240	410	390	410	400	350	320
155. Arsenic	2	46	38	30	29	27	33
156. Barium	9	480	500	530	550	600	570
157. Beryllium	1	ND	ND	ND	ND	2	ND
158. Cadmium	3	230	190	150	130	120	110
159. Chromium	9	110	140	130	140	140	130
160. Copper	10	1810	1380	1180	1130	1030	870
161. Lead	80	820	780	640	600	480	400
162. Mercury	0.2	2	2.6	1.5	0.4	1	1
163. Nickel	20	81	68	57	65	67	61
165. Silver	9	85	95	92	92	90	92
167. Vanadium	20	160	180	150	150	160	160
168. Zinc	6	11,400	11,000	9500	9980	11,100	10,400
INORGANICS							
170. Fluoride	10	20,000	15,000	14,000	13,000	12,000	12,000

ND - The compound was not quantified at or above the detection limit.

Note: This table shows the concentrations in the scrubber water for all constituents that were detected in the wastewater residuals generated from treatment of the waste.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

Table 4-5

DESIGN AND OPERATING DATA FOR THE ROTARY KILN AND SECONDARY COMBUSTOR

Parameter (units)	Design Value	SAMPLE SET #1	SAMPLE SET #2	SAMPLE SET #3	SAMPLE SET #4	SAMPLE SET #5	SAMPLE SET #6
Kiln Outlet Temperature (^{o}F)	o	1825-1900	1800-1880	1850-1900	1775-1900	1775-1800	1775-1850
Kiln Solids Residence Time (min)	o	120	120	120	120	120	120
Kiln Waste Feed Rate (MMBTU/hr)	o						
K019:		13.1	12.2	12.4	12.7	11.7	11.5
RCRA Blend, Burner #1:		3.9-5.5	5.2-5.5	5.2-5.8	5.2-5.8	5.2-6.0	5.2-5.8
RCRA Blend, Burner #2:		4.4-9.7	4.4-9.7	4.4-8.4	4.4-7.3	5.2-9.7	5.2-9.7
	Total:	21.4-28.3	21.8-27.4	22.0-26.6	22.3-25.8	22.1-27.4	21.9-27
Kiln Rotational Speed (RPM)	o	0.19-0.21	0.19-0.21	0.19-0.21	0.19-0.21	0.19-0.21	0.19-0.21
Afterburner Temperature (^{o}F)	o	2380	2400	2400	2400	2400	2350
Afterburner Residence Time (sec)	o	2	2	2	2	2	2
Afterburner Waste Feed Rate (MMBTU/hr)	o						
PCB Blend:		36.1	36.5	36.5	36.5	37.5	37.5
Mercaptan-Contaminated Waste:		0.18	0.18	0.18	0.18	0.18	0.18
	Total:	36.28	36.68	36.68	36.68	37.68	37.68
Stack Oxygen Concentration (%)	NA	6.8	7.0	7.2	6.4	6.8	7.0
Stack Carbon Monoxide Concentration (ppm volume)	NA	NR	NR	0	0	NR	NR

o This information has been claimed as RCRA Confidential Business Information and is available in the confidential portion of the Administrative Record for the First Thirds Rulemaking of August 17, 1988.

Source: BDAT Background Document for K016, K018, K019, K020, K030 (Reference 3).

NA - Not applicable.
NR - Not recorded.

Table 4-6

TCLP ANALYTICAL RESULTS FOR THE F024 ROTARY KILN INCINERATOR ASH SAMPLES

CEMENT BINDER
Binder-to-Ash Ratio: 0.55
Water-to-Ash Ratio: 0.2

BDAT List Constituent	Detection Limit (mg/l)	Concentration in the TCLP Extract of the Untreated Waste (mg/l) Sample Set 1	2	3	Concentration in the TCLP Extract of the Treated Waste (28-Day Cure) (mg/l) Sample Set 1	2	3	Detection Limit (mg/l)	Concentration in the TCLP Extract of the Treated Waste (24-Hour Cure) (mg/l)
154. Antimony	0.076	ND	ND	ND	ND	ND	ND	0.11	ND
155. Arsenic	0.002	0.013	0.015	0.014	0.004	0.002	0.002	0.002	0.002
156. Barium	0.002	1.99	1.72	1.67	1.84	0.88	1.02	0.002	3.19
157. Beryllium	0.001	0.002	0.002	0.002	ND	ND	ND	0.002	ND
158. Cadmium	0.003	0.021	0.021	0.021	ND	ND	ND	0.004	ND
159. Chromium (total)	0.007	0.4	0.41	0.42	0.031	0.01	0.013	0.003	0.031
221. Chromium (VI)	0.006	0.34	0.075	0.049	0.19	0.15	0.14	0.045	0.045
160. Copper	0.018	5.54	6.71	9.59	ND	ND	ND	0.013	0.014
161. Lead	0.057	63.3	33.3	14.9	0.011	0.006	0.007	0.001	0.24
162. Mercury	0.0003	0.0006	ND	ND	ND	ND	ND	0.0003	ND
163. Nickel	0.025	4.39	3.96	3.93	ND	ND	ND	0.042	ND
164. Selenium	0.002	ND	ND	ND	ND	ND	ND	0.002	0.003
165. Silver	0.004	ND	ND	ND	ND	ND	ND	0.006	ND
166. Thallium	0.004	ND	ND	ND	ND	ND	ND	0.004	ND
167. Vanadium	0.007	ND	ND	ND	ND	ND	ND	0.008	ND
168. Zinc	0.003	2.06	2.07	2.06	0.041	0.05	0.173	0.023	0.11
* Aluminum	0.023	15.8	16.9	16.4	0.45	0.28	0.26	0.021	0.41
* Calcium	0.001	588	584	588	2003	1870	1880	0.003	2340
* Cobalt	0.01	0.06	0.053	0.049	ND	0.012	ND	0.023	ND
* Iron	0.012	13.1	12.8	13.2	0.022	0.037	0.17	0.023	0.074
* Magnesium	0.001	146	140	145	0.095	0.30	1.28	0.002	0.046
* Manganese	0.001	1.98	2.19	2.21	ND	ND	0.001	0.002	ND
* Molybdenum	0.037	ND	0.041	ND	0.062	0.056	0.078	0.088	ND
* Sodium	0.021	45	44.8	45.1	37.4	37.2	37.4	0.028	35.2
* Tin	0.105	1.04	0.43	0.32	ND	ND	ND	0.103	ND

* non-BDAT List constituent
ND-Not detected.
Source: Onsite Engineering Report of Stabilization of F024 Rotary Kiln Incinerator Ash at Waterways Experiment Station (Reference 10).

Table 4-7

TEST CONDITIONS COMMON TO ALL BATCHES OF STABILIZED F024 INCINERATION ASH

Parameter	Specification
Mixing Vessel	Hobart K455S Mixer With Teflon Beaters 4-Liter Stainless Steel Bowl
Mixing Conditions	Mixing Procedure Used for All Batches: Mix 5 minutes Stir with stainless steel spatula
Cure Conditions	Hot Pack Model 41750 Large Capacity Humidity Chamber with set point conditions of: Temperature: 23°C Humidity: 95-98%

Source: Onsite Engineering Report of Stabilization of F024 Rotary Kiln Incinerator Ash at Waterways Experiment Station (Reference 10).

Table 4-8

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR TREATMENT OF K062 BY CHEMICAL PRECIPITATION FOLLOWED BY VACUUM FILTRATION[a]

BDAT LIST METAL CONSTITUENT	Sample Set #8		Sample Set #11		Sample Set #12	
	Concentration in Untreated K062 Mixture (ppm)	Concentration in Treated K062 Mixture Wastewater (ppm)	Concentration in Untreated K062 Mixture (ppm)	Concentration in Treated K062 Mixture Wastewater (ppm)	Concentration in Untreated K062 Mixture (ppm)	Concentration in Treated K062 Mixture Wastewater (ppm)
154. Antimony	<10	<1	<10	<1	<10	<1.00
155. Arsenic	<1	<0.1	<1	<0.1	<1	<0.10
156. Barium	<10	<1	<10	<1	12	<1.00
157. Beryllium	<2	<0.2	<2	<0.2	<2	<0.20
158. Cadmium	<5	<0.5	<5	<0.5	23	<5
221. Chromium (hexavalent)	0.13	<0.01	0.08	0.106	0.30	<0.01
159. Chromium (total)	831	0.15	395	0.12	617	0.18
160. Copper	217	0.16	191	0.14	137	0.24
161. Lead	212	<0.01	<10	<0.01	136	<0.01
162. Mercury	<1	<0.1	<1	<0.1	<1	<0.10
163. Nickel	669	0.36	712	0.33	382	0.39
164. Selenium	<10	<1	<10	<1	<10	<1.00
165. Silver	<2	<0.2	<2	<0.2	<2	<0.20
166. Thallium	<10	<1	<10	<1	<10	<1.00
168. Zinc	151	0.130	5	0.070	135	0.100

[a]Only 3 of the 12 data sets analyzed at Plant B represented treatment by this treatment train. Other data sets included pretreatment technologies such as chromium reduction and treatment for cyanide. These data are not included here, since they were not considered for transfer, as discussed in Section 3.2 of this document.

Source: Envirite Onsite Engineering Report (Reference 12).

5.0 IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section discusses technologies that are available for treatment of K083 nonwastewaters and wastewaters and identifies BDAT for K083 nonwastewaters and wastewaters.

For a treatment technology to be identified as BDAT, the treatment performance data are first screened to determine whether they represent a well-designed and well-operated treatment system, whether sufficient analytical quality assurance/quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measures of performance were used to assess the performance of the particular treatment technology.

The treatment performance data and the design and operating data collected during the tests of rotary kiln incineration, stabilization, and chemical precipitation followed by vacuum filtration were reviewed for the points described above. For all of these tests, the appropriate measures of performance (total constituent concentration for organic constituents in nonwastewater and for organic and metal constituents in wastewater, and TCLP leachate concentration for metal constituents in nonwastewater) was used to assess the treatment systems. Additionally, the Agency had no reason to believe that these treatment systems were not well-designed and well-operated, or that insufficient analytical quality assurance/quality control measures were employed in generating treatment performance data.

An available treatment technology is one that (1) is not a proprietary or patented process that cannot be purchased or licensed from the proprietor (i.e., it must be commercially available), and (2) substantially diminishes the toxicity of the waste or substantially reduces the likelihood of migration of hazardous constituents from the waste. Because the Agency does not have treatment performance data for biological treatment, steam stripping, and carbon adsorption, these technologies cannot be evaluated for availability. The remaining technologies that are demonstrated for treatment of K083, incineration, stabilization, and chemical precipitation followed by vacuum filtration, are considered to be commercially available and to provide substantial treatment of the waste. Therefore, incineration followed by stabilization is "available" for treatment of nonwastewater forms of K083 and incineration followed by chemical precipitation and vacuum filtration is "available" for treatment of wastewater forms of K083.

In summary, incineration, stabilization, and chemical precipitation followed by vacuum filtration have been determined to be demonstrated and available for treatment of K083. However, because the Agency does not have treatment performance data for any other demonstrated and available technologies treating K083 or similar wastes, these treatment technologies are considered to be the best. Therefore, the best demonstrated available technology (BDAT) has been determined to be incineration for organic constituents in K083 nonwastewaters and wastewaters, stabilization for metal constituents in K083 nonwastewaters, and chemical precipitation followed by vacuum filtration for metal constituents in K083 wastewaters.

6.0 SELECTION OF CONSTITUENTS PROPOSED FOR REGULATION

The Agency has developed a list of hazardous constituents (the BDAT Constituent List, presented in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1)) from which constituents to be regulated are selected for regulation. EPA may revise this list as additional data and information become available. The list is divided into the following categories: volatile organics, semivolatile organics, metals, inorganics other than metals, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorus insecticides, PCBs, and dioxins and furans. This section presents the rationale for the selection of constituents being proposed for regulation in wastewater and nonwastewater forms of K083.

Generally, constituents selected for proposed regulation must satisfy the following criteria:

(1) The constituent must be on the BDAT List of regulated constituents. Presence on the BDAT List means that approved methods to analyze for the constituent in treated waste matrices exist.

(2) The constituent must be present in, or be suspected of being present in, the untreated waste. For example, in some cases, analytical difficulties (such as masking) may prevent a constituent from being identified in the untreated waste, but its identification in a treatment residual may lead the Agency to conclude that it is present in the untreated waste.

From a group of constituents that are eligible for regulation, because they meet the above criteria, EPA may select a subset of constituents that represent the broader group. For example, from a group of constituents that react similarly to treatment, the Agency may select for regulation those

constituents that (1) are the most difficult to treat, based on waste characteristics affecting performance of treatment; (2) are representative of other constituents in the waste, based on structural similarities; or (3) are present in the untreated waste in the highest concentrations. Selecting a subset of constituents for regulation is done to facilitate implementation of the compliance and enforcement program.

The Agency initially considered all constituents on the BDAT List for regulation. Available K083 characterization data for all BDAT List constituents are summarized in Table 6-1. (All tables are presented at the end of Section 6.0.) When data are available from more than one source, a range of detected concentrations is shown in the table for all constituents quantified in the untreated K083. Constituents for which analytical results were not reported in available literature are identified by the notation "NR" (not reported).

6.1 BDAT List Constituents Not Selected for Proposed Regulation

The Agency may not regulate all of the BDAT List constituents initially considered for regulation. As discussed further below, a BDAT List constituent is deleted from further consideration for regulation if (1) the constituent was not detected in the untreated and/or treated wastes, (2) the constituent was not analyzed for in the untreated waste, or (3) other reasons, as discussed below. BDAT List constituents that remained following the deletions described in this subsection were further considered for regulation.

These constituents were further considered for regulation and are listed in Table 6-2 at the end of this section.

BDAT List Constituents That Were Not Detected or Analyzed for in the Untreated Waste. Constituents for which the Agency does not have analytical results from characterization samples (identified by "NR" in Table 6-1) were deleted from further consideration for proposed regulation.

BDAT List Constituents That Were Deleted From Consideration for Proposed Regulation for Other Reasons. Copper was considered for proposed regulation in K083 nonwastewaters and wastewaters but was not selected as a constituent to be proposed for regulation. Although copper cyanide is listed in Appendix VIII of 40 CFR Part 261, copper is not listed individually. The Agency is only proposing to regulate copper when it is an indicator of performance of treatment for other Appendix VIII constituents. For K083 nonwastewaters and wastewaters, copper has not been identified as an indicator of treatment performance for other Appendix VIII constituents and therefore, is not being proposed for regulation.

Lead was deleted from further consideration for proposed regulation in K083 because it was not present in the untreated waste at treatable concentrations.

Sulfide was deleted from further consideration for proposed regulation in K083 because the technologies determined to be BDAT for K083

(incineration, stabilization, and chemical precipitation followed by vacuum filtration) do not provide effective treatment for sulfide. Moreover, the Agency is unaware of any demonstrated technology for treatment of sulfide in K083 or similar wastes.

6.2 Selection of BDAT List Constituents for Proposed Regulation

Constituents considered further for proposed regulation in nonwastewater and wastewater forms of K083 were selected from the BDAT List constituents that were detected in the untreated waste, unless they were deleted from consideration as discussed in Section 6.1.

Table 6-2 presents each constituent selected for proposed regulation in K083 nonwastewaters and wastewaters after consideration of (1) the constituent concentration in the untreated waste, (2) whether the constituent is adequately controlled by regulation of another constituent, and (3) the relative difficulty in achieving effective treatment of the constituent by the technology identified as BDAT for K083 (incineration for organic constituents, stabilization for metal constituents in nonwastewater, and chemical precipitation followed by vacuum filtration for metal constituents in wastewater).

The Agency's determination of adequate control for organic constituents was based on (1) an evaluation of the characteristics of the constituents that would affect the performance of incineration relative to the residuals, specifically, their estimated boiling points for ash residuals and their bond

dissociation energies for scrubber water residuals, and (2) the structural similarities among the constituents.

Based on the above considerations, the seven BDAT List organic constituents selected for proposed regulation (shown in Table 6-2) in K083 nonwastewaters and wastewaters are benzene, aniline, diphenylamine, diphenylnitrosamine, nitrobenzene, cyclohexanone, and phenol. One metal constituent, nickel, was also selected for proposed regulation in nonwastewater and wastewater forms of K083.

Table 6-1

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Volatiles	
222.	Acetone	NR
1.	Acetonitrile	NR
2.	Acrolein	NR
3.	Acrylonitrile	NR
4.	Benzene	2,000-58,000
5.	Bromodichloromethane	NR
6.	Bromomethane	NR
223.	n-Butyl alcohol	NR
7.	Carbon tetrachloride	NR
8.	Carbon disulfide	NR
9.	Chlorobenzene	NR
10.	2-Chloro-1,3-butadiene	NR
11.	Chlorodibromomethane	NR
12.	Chloroethane	NR
13	2-Chloroethyl vinyl ether	NR
14.	Chloroform	NR
15.	Chloromethane	NR
16.	3-Chloropropene	NR
17.	1,2-Dibromo-3-chloropropane	NR
18.	1,2-Dibromoethane	NR
19.	Dibromomethane	NR
20.	trans-1,4-Dichloro-2-butene	NR
21.	Dichlorodifluoromethane	NR
22.	1,1-Dichloroethane	NR
23.	1,2-Dichloroethane	NR
24.	1,1-Dichloroethylene	NR
25.	trans-1,2-Dichloroethene	NR
26.	1,2-Dichloropropane	NR
27.	trans-1,3-Dichloropropene	NR
28.	cis-1,3-Dichloropropene	NR
29.	1,4-Dioxane	NR
225.	Ethyl acetate	NR
226.	Ethyl benzene	NR
30.	Ethyl cyanide	NR
227.	Ethyl ether	NR
31.	Ethyl methacrylate	NR
214.	Ethylene oxide	NR
32.	Iodomethane	NR

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Volatiles (Continued)	
33.	Isobutyl alcohol	NR
228.	Methanol	NR
34.	Methyl ethyl ketone	NR
229.	Methyl isobutyl ketone	NR
35.	Methyl methacrylate	NR
37.	Methacrylonitrile	NR
38.	Methylene chloride	NR
39.	Pyridine	NR
40.	1,1,1,2-Tetrachloroethane	NR
41.	1,1,2,2-Tetrachloroethane	NR
42.	Tetrachloroethene	NR
43.	Toluene	NR
44.	Tribromomethane	NR
45.	1,1,1-Trichloroethane	NR
46.	1,1,2-Trichloroethane	NR
47.	Trichloroethene	NR
48.	Trichloromonofluoromethane	NR
49.	1,2,3-Trichloropropane	NR
231.	1,1,2-Trichloro-1,2,2-trifluoroethane	NR
50.	Vinyl chloride	NR
215.	1,2-Xylene	NR
216.	1,3-Xylene	NR
217.	1,4-Xylene	NR
	Semivolatiles	
51.	Acenaphthalene	NR
52.	Acenaphthene	NR
53.	Acetophenone	NR
54.	2-Acetylaminofluorene	NR
233.	Acrylamide	NR
55.	4-Aminobiphenyl	NR
56.	Aniline	40,000-550,000
57.	Anthracene	NR
58.	Aramite	NR
59.	Benz(a)anthracene	NR
218.	Benzal chloride	NR
60.	Benzenethiol	NR
62.	Benzo(a)pyrene	NR

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Semivolatiles (Continued)	
63.	Benzo(b)fluoranthene	NR
64.	Benzo(ghi)perylene	NR
65.	Benzo(k)fluoranthene	NR
66.	p-Benzoquinone	NR
67.	Bis(2-chloroethoxy)methane	NR
68.	Bis(2-chloroethyl)ether	NR
69.	Bis(2-chloroisopropyl)ether	NR
70.	Bis(2-ethylhexyl)phthalate	NR
71.	4-Bromophenyl phenyl ether	NR
72.	Butyl benzyl phthalate	NR
73.	2-sec-Butyl-4,6-dinitrophenol	NR
74.	p-Chloroaniline	NR
75.	Chlorobenzilate	NR
76.	p-Chloro-m-cresol	NR
77.	2-Chloronaphthalene	NR
78.	2-Chlorophenol	NR
80.	Chrysene	NR
81.	ortho-Cresol	NR
82.	para-Cresol	NR
232.	Cyclohexanone	2,000
83.	Dibenz(a,h)anthracene	NR
84.	Dibenzo(a,e)pyrene	NR
86.	m-Dichlorobenzene	NR
87.	o-Dichlorobenzene	NR
88.	p-Dichlorobenzene	NR
89.	3,3'-Dichlorobenzidine	NR
234.	cis-1,4-Dichloro-2-butene	NR
90.	2,4-Dichlorophenol	NR
91.	2,6-Dichlorophenol	NR
92.	Diethyl phthalate	NR
93.	3,3'-Dimethoxybenzidine	NR
94.	p-Dimethylaminoazobenzene	NR
95.	3,3'-Dimethylbenzidine	NR
96.	2,4-Dimethylphenol	NR
97.	Dimethyl phthalate	NR
98.	Di-n-butyl phthalate	NR
99.	1,4-Dinitrobenzene	NR
100.	4,6-Dinitro-o-cresol	NR
101.	2,4-Dinitrophenol	NR

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Semivolatiles (Continued)	
102.	2,4-Dinitrotoluene	NR
103.	2,6-Dinitrotoluene	NR
104.	Di-n-octyl phthalate	NR
105.	Di-n-propylnitrosamine	NR
106./ 219.	Diphenylamine/ Diphenylnitrosamine	1,700
107.	1,2-Diphenylhydrazine	NR
108.	Fluoranthene	NR
109.	Fluorene	NR
110.	Hexachlorobenzene	NR
111.	Hexachlorobutadiene	NR
112.	Hexachlorocyclopentadiene	NR
113.	Hexachloroethane	NR
114.	Hexachlorophene	NR
115.	Hexachloropropene	NR
116.	Indeno(1,2,3-cd)pyrene	NR
117.	Isosafrole	NR
118.	Methapyrilene	NR
119.	3-Methylcholanthrene	NR
120.	4,4'-Methylenebis(2-chloroaniline)	NR
36.	Methyl methanesulfonate	NR
121.	Naphthalene	NR
122.	1,4-Naphthoquinone	NR
123.	1-Naphthylamine	NR
124.	2-Naphthylamine	NR
125.	p-Nitroaniline	NR
126.	Nitrobenzene	NR
127.	4-Nitrophenol	1,000-10,000
128.	n-Nitrosodi-n-butylamine	NR
129.	n-Nitrosodiethylamine	NR
130.	n-Nitrosodimethylamine	NR
131.	n-Nitrosomethylethylamine	NR
132.	n-Nitrosomorpholine	NR
133.	n-Nitrosopiperidine	NR
134.	n-Nitrosopyrrolidine	NR
135.	5-Nitro-o-toluidine	NR
136.	Pentachlorobenzene	NR
137.	Pentachloroethane	NR
138.	Pentachloronitrobenzene	NR

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Semivolatiles (Continued)	
139.	Pentachlorophenol	NR
140.	Phenacetin	NR
141.	Phenanthrene	NR
142.	Phenol	35,000
220.	Phthalic anhydride	NR
144.	Pronamide	NR
145.	Pyrene	NR
146.	Resorcinol	NR
147.	Safrole	NR
148.	1,2,4,5-Tetrachlorobenzene	NR
149.	2,3,4,6-Tetrachlorophenol	NR
150.	1,2,4-Trichlorobenzene	NR
151.	2,4,5-Trichlorophenol	NR
152.	2,4,6-Trichlorophenol	NR
153.	Tris(2,3-dibromopropyl)phosphate	NR
	Metals	
154.	Antimony	NR
155.	Arsenic	NR
156.	Barium	NR
157.	Beryllium	NR
158.	Cadmium	NR
159.	Chromium (total)	NR
221.	Chromium (hexavalent)	NR
160.	Copper	2.5
161.	Lead	1.9-3.0
162.	Mercury	NR
163.	Nickel	345
164.	Selenium	NR
165.	Silver	NR
166.	Thallium	NR
167.	Vanadium	NR
168.	Zinc	NR
	Inorganics	
169.	Cyanide	<0.05
170.	Fluoride	NR
171.	Sulfide	21,000

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	Organochlorine pesticides	
172.	Aldrin	NR
173.	alpha-BHC	NR
174.	beta-BHC	NR
175	delta-BHC	NR
176.	gamma-BHC	NR
177.	Chlordane	NR
178.	DDD	NR
235.	o,p'-DDD	NR
179.	DDE	NR
236.	o,p'-DDE	NR
180.	DDT	NR
237.	o,p'-DDT	NR
181.	Dieldrin	NR
182.	Endosulfan I	NR
183.	Endosulfan II	NR
238.	Endosulfan sulfate	NR
184.	Endrin	NR
185.	Endrin aldehyde	NR
186.	Heptachlor	NR
187.	Heptachlor epoxide	NR
188.	Isodrin	NR
189.	Kepone	NR
190.	Methoxychlor	NR
191.	Toxaphene	NR
	Phenoxyacetic acid herbicides	
192.	2,4-Dichlorophenoxyacetic acid	NR
193.	Silvex	NR
194.	2,4,5-T	NR
	Organophosphorous insecticides	
195.	Disulfoton	NR
196.	Famphur	NR
197.	Methyl parathion	NR
198.	Parathion	NR
199.	Phorate	NR

NR - Not reported.
Source: See References 4, 5, 6, and 7.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENT PRESENCE IN UNTREATED K083

BDAT Reference No.	Parameter	Concentration in Untreated K083 (ppm)
	PCBs	
200.	Aroclor 1016	NR
201.	Aroclor 1221	NR
202.	Aroclor 1232	NR
203.	Aroclor 1242	NR
204.	Aroclor 1248	NR
205.	Aroclor 1254	NR
206.	Aroclor 1260	NR
	Dioxins and furans	
207.	Hexachlorodibenzo-p-dioxins	NR
208.	Hexachlorodibenzofurans	NR
209.	Pentachlorodibenzo-p-dioxins	NR
210.	Pentachlorodibenzofurans	NR
211.	Tetrachlorodibenzo-p-dioxins	NR
212.	Tetrachlorodibenzofurans	NR
213.	2,3,7,8-Tetrachlorodibenzo-p-dioxin	NR

NR - Not reported.

Source: See References 4, 5, 6, and 7.

Table 6-2

BDAT LIST CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN K083 NONWASTEWATERS AND WASTEWATERS

4.	Benzene
56.	Aniline
106./219.	Diphenylamine/Diphenylnitrosamine
126.	Nitrobenzene
142.	Phenol
232.	Cyclohexanone
163.	Nickel

7.0 CALCULATION OF PROPOSED BDAT TREATMENT STANDARDS

The Agency bases numerical treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards must account for analytical limitations in available treatment performance data, and the data must be adjusted for variabilities related to treatment, sampling, and analytical techniques and procedures. The purpose of this section is to calculate proposed treatment standards for K083 nonwastewaters and wastewaters for the constituents selected for proposed regulation using the available treatment performance data from the treatment technologies identified as BDAT.

Proposed BDAT treatment standards for K083 nonwastewaters are based on the demonstrated technologies of incineration and/or fuel substitution for organic constituents and stabilization for metal constituents.

Proposed BDAT treatment standards for wastewater forms of K083 are based on the demonstrated technologies of incineration for organic constituents and chemical precipitation followed by vacuum filtration for metal constituents.

Before treatment standards are calculated, the treatment performance data are corrected to account for analytical interferences associated with the chemical matrices of the samples. A complete discussion of the accuracy correction of treatment performance data is provided in Appendix A. Appendix

A also contains the matrix spike recoveries and accuracy correction factors used to correct the treatment performance data, as well as the corrected treatment performance data.

After treatment performance data are corrected for accuracy, the arithmetic average of the corrected data is calculated for each regulated constituent. In cases where the constituent is not detected in the treatment residual at or above its detection limit, the detection limit is used to calculate the average constituent concentration in the treated waste. Tables 7-1 and 7-2 at the end of this section present the averages of the corrected treatment performance data for each constituent proposed for regulation in K083 nonwastewaters and wastewaters, respectively.

The next step in calculating treatment standards is to determine the variability factor (VF) for each regulated constituent. The variability factor accounts for the variability inherent in treatment system performance, treatment residual collection, and treatment sample analysis. (For more information on calculation of variability factors, see EPA's Methodology for Developing BDAT Treatment Standards (Reference 1).) Variability factors for the constituents proposed for regulation in K083 are shown in Tables 7-1 and 7-2.

Finally, the treatment standard is calculated for each constituent proposed for regulation by multiplying the average of the corrected treatment performance values by the variability factor for the constituent. Proposed

treatment standards for nonwastewater and wastewater forms of K083 are presented in Tables 7-1 and 7-2 and are discussed in greater detail in the following sections.

7.1 Calculation of Proposed Treatment Standards for K083 Nonwastewaters

Treatment performance data for rotary kiln incineration and/or fuel substitution of organic constituents and stabilization of metal constituents in K083 are not available. Therefore, the Agency is transferring performance data from treatment of RCRA Blend waste to develop treatment standards for organic constituents in nonwastewater forms of K083 and from treatment of F024 to develop treatment standards for metal constituents in nonwastewater forms of K083. The rationale for these transfers is presented in Section 4.0 of this document.

Organic Constituents

Incineration generally results in the generation of ash (a nonwastewater) and combustion gas scrubber water (a wastewater). The best measure of performance for a destruction technology, such as incineration, is the total amount of each constituent of concern remaining after treatment. Therefore, BDAT treatment standards for organic constituents proposed for regulation in K083 nonwastewaters were calculated based on total constituent concentration data transferred from the ash residual from incineration of RCRA Blend waste (Reference 16).

Proposed treatment standards for organic constituents in K083 nonwastewaters were calculated using six sample sets of data for incineration of RCRA Blend waste (Reference 16). Tables 4-2 and 4-3 of this document present the total concentrations of each organic constituent detected in untreated RCRA Blend waste and the treated nonwastewater residual (ash). Treatment performance data for each constituent being proposed for regulation in K083 nonwastewaters were transferred from data for the same constituent in RCRA Blend waste if that constituent was detected in the untreated RCRA Blend waste. For a constituent that was not detected in the untreated RCRA Blend waste, a treatment standard was developed based on treatment performance data from another constituent that was detected in the untreated RCRA Blend waste.

The particular constituent from which data are transferred is determined based on the characteristics of the waste that affect treatment performance by incineration and fuel substitution with respect to the nonwastewater residual (i.e., ash) and the structural similarities between the constituents from and to which data are transferred. In the rotary kiln, energy in the form of heat is transferred to the waste to volatilize the organic waste constituents. To determine whether one constituent is volatilized similarly to another constituent, the Agency examines the boiling points and the structural similarities of the constituents.

In general, the Agency believes that a constituent with a higher boiling point (bp) is more difficult to treat than a constituent with a lower boiling point. Whenever possible, treatment performance data were transferred

to K083 nonwastewaters from constituents detected in untreated RCRA Blend waste that had equal or higher boiling points. Specific cases where data were transferred from another constituent are noted in Table 7-1 at the end of this section.

The calculation of the treatment standards for each BDAT List organic constituent proposed for regulation in K083 nonwastewaters is shown in Table 7-1.

Metal Constituents

Stabilization is an immobilization technology for metals in nonwastewater. The best measure of performance for an immobilization technology is the concentration of each constituent of concern in the leachate from the stabilized material. Therefore, the Agency is transferring performance data from stabilization of metal constituents in F024 incinerator ash to develop treatment standards for metal constituents in nonwastewater forms of K083. The rationale for this transfer is presented in Section 4.0 of this document.

Treatment standards for metal constituents in K083 nonwastewaters were calculated using three sample sets of data for stabilization of F024 incinerator ash using a cement binder. Table 4-6 of this document presents the TCLP leachate concentrations for metal constituents in the untreated and treated F024 incinerator ash.

The accuracy-corrected data and treatment standard calculations for the metal constituents proposed for regulation in nonwastewater forms of K083 are presented in Table 7-1.

7.2 Calculation of Proposed Treatment Standards for K083 Wastewaters

Treatment performance data from incineration of K083 are not available. Therefore, the Agency is transferring performance data from treatment of RCRA Blend waste to develop treatment standards for organic constituents in wastewater forms of K083 and from treatment of K062 to develop treatment standards for metal constituents in wastewater forms of K083. The rationale for these transfers is presented in Section 4.0 of this document.

Organic Constituents

Incineration generally results in the generation of ash (a nonwastewater) and combustion gas scrubber water (a wastewater). The best measure of performance for a destruction technology, such as incineration, is the total amount of each constituent of concern remaining after treatment. Therefore, BDAT treatment standards for organic constituents proposed for regulation in K083 wastewaters were calculated based on total constituent concentration data transferred from the scrubber water residual from incineration of RCRA Blend waste (Reference 16).

Proposed treatment standards for organic constituents in K083 wastewaters were calculated using six sample sets of data from incineration of RCRA Blend waste. Tables 4-2 and 4-4 of this document present the total concentrations of each organic constituent detected in the untreated RCRA Blend and the treated wastewater residual (scrubber water). Treatment performance data for each constituent being proposed for regulation in K083 wastewaters were transferred from data for the same constituent in RCRA Blend waste if that constituent was detected in the untreated RCRA Blend waste. For a constituent that was not detected in the untreated RCRA Blend waste, a treatment standard was developed based on treatment performance data from another constituent that was detected in the untreated RCRA Blend waste that was tested.

The particular constituent from which data are transferred is determined based on the characteristics of the waste that affect treatment performance by incineration with respect to the wastewater residual (scrubber water) and the structural similarities between the constituents from and to which data are transferred. In the secondary chamber (or afterburner), energy in the form of heat is added to destabilize chemical bonds to initiate combustion reactions. To determine whether one constituent is destabilized similarly to another constituent, the Agency examines the bond dissociation energies and the structural similarities of the constituents.

In general, the Agency believes that a constituent with a higher bond dissociation energy (BDE) is more difficult to treat than a constituent

with a lower BDE. Whenever possible, treatment performance data were transferred to K083 wastewaters from constituents detected in untreated RCRA Blend waste that had an equal or higher BDE. Specific cases where data were transferred from another constituent are noted in Table 7-2 at the end of this section.

The calculation of the treatment standards for each BDAT List organic constituent proposed for regulation in K083 wastewaters is shown in Table 7-2.

Metal Constituents

Chemical precipitation followed by vacuum filtration is a removal technology for metals in wastewater. The best measure of performance for a removal technology is the total amount of each constituent of concern remaining in the wastewater after treatment. Therefore, the Agency is transferring performance data from treatment of metal constituents in K062 mixed with metal-bearing characteristic hazardous wastes to develop treatment standards for metal constituents in wastewater forms of K083. The rationale for this transfer is presented in Section 4.0 of this document.

Treatment standards for metal constituents in K083 wastewaters were calculated using three sample sets of data for chemical precipitation followed by vacuum filtration of K062 mixed with metal-bearing characteristic hazardous wastes. Table 4-8 of this document presents the total concentrations for

metal constituents in the untreated and treated K062 mixed with metal-bearing characteristic hazardous wastes.

The accuracy-corrected data and treatment standard calculations for the metal constituents proposed for regulation in wastewater forms of K083 are presented in Table 7-2.

Table 7-1

CALCULATION OF TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083

NONWASTEWATERS

BDAT List Constituent Proposed for Regulation	Constituent from Which Treatment Performance Data in RCRA Blend Waste Were Transferred	Arithmetic Average of Corrected Treatment Performance Values (ppm)	Variability Factor (VF)	Treatment Standard (Average x VF) (ppm)
4. Benzene	Benzene	2.352	2.8	6.6
56. Aniline	Nitrobenzene	5.0	2.8	14
106./219. Diphenylamine/ Diphenylnitrosamine	Nitrobenzene	5.0	2.8	14
126. Nitrobenzene	Nitrobenzene	5.0	2.8	14
142. Phenol	Phenol	2.0	2.8	5.6
232. Cyclohexanone	Methyl isobutyl ketone	10.6	2.8	30
163. Nickel	Nickel	0.031	2.8	0.088

[a]The treatment standard represents the sum of the concentrations of diphenylamine and diphenylnitrosamine.

Table 7-2

CALCULATION OF TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083

WASTEWATERS

BDAT List Constituent Proposed for Regulation	Constituent from Which Treatment Performance Data in RCRA Blend Waste Were Transferred	Arithmetic Average of Corrected Treatment Performance Values (ppm)	Variability Factor (VF)	Treatment Standard (Average x VF) (ppm)
4. Benzene	Benzene	0.0029	2.8	0.008
56. Aniline	Nitrobenzene	0.006	2.8	0.017
106./219. Diphenylamine/ Diphenylnitrosamine	Nitrobenzene	0.006	2.8	0.017[a]
126. Nitrobenzene	Nitrobenzene	0.006	2.8	0.017
142. Phenol	Phenol	0.0028	2.8	0.0078
232. Cyclohexanone	Methyl isobutyl ketone	0.013	2.8	0.036
163. Nickel	Nickel	0.387	1.212	0.47

[a]The treatment standard represents the sum of the concentrations of diphenylamine and diphenylnitrosamine.

8.0 ACKNOWLEDGEMENTS

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The following personnel from Radian Corporation were involved in preparing this document: Mr. John Williams, Program Manager; Ms. Lori Stoll, Project Director; and the Radian engineering team, Ms. Debra Falatko, Ms. Chrisanti Haretos and Ms. Colleen Kane.

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Appendix A

ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA

Appendix A

ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA

The treatment performance data used to determine treatment standards for K083 were adjusted to account for analytical interferences associated with the chemical matrices of the samples. Generally, treatment performance data were corrected for accuracy as follows: (1) a matrix spike recovery was determined for each BDAT List constituent detected in the untreated or treated waste; (2) an accuracy correction factor was determined for each of the above constituents by dividing 100 by the matrix spike recovery (percent) for that constituent; and (3) treatment performance data for each BDAT List constituent detected in the untreated or treated waste were corrected by multiplying the reported concentration of each constituent by its corresponding accuracy correction factor. The procedure for accuracy correction of the data is described in further detail below.

Matrix spike recoveries are developed by analyzing a sample of a treated waste for a constituent and then re-analyzing the sample after the addition of a known amount of the same constituent (i.e., spike) to the sample. The matrix spike recovery represents the total amount of constituent recovered after spiking, minus the initial concentration of the constituent in the sample, and the result divided by the spike concentration of the constituent.

Matrix spike recoveries that were used to adjust the treatment performance data transferred to K083 are shown in Tables A-1 and A-2. Duplicate matrix spikes were performed for some BDAT List constituents. If a duplicate matrix spike was performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike. An accuracy correction factor of 1 was used when matrix spike and duplicate matrix spike recoveries both exceeded 100%, so that the data were not adjusted to concentrations below the detection limits.

Where a matrix spike was not performed for an organic constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (e.g., volatile or semivolatile organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatiles or semivolatiles from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile or semivolatile group was used for any volatile or semivolatile constituent for which no matrix spike was performed.

The accuracy correction factors for the data that were used to adjust the treatment performance data transferred to K083 are presented in Table A-3. The corrected treatment concentrations for the constituents

proposed for regulation in K083 nonwastewaters and wastewaters are presented in Tables A-4 and A-5.

Table A-1

MATRIX SPIKE RECOVERIES FOR NONWASTEWATER RESIDUALS

Spike Constituent	Original Amount Found (ppm)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)
VOLATILE ORGANICS							
4. Benzene	<2	25	22.6	90	25	21.2	85
9. Chlorobenzene	<2	25	24.8	99	25	25	100
24. 1,1-Dichloroethene	<2	25	21.2	85	25	19.4	78
47. Trichloroethene	<2	25	26.8	107	25	28	112
SEMIVOLATILE ORGANICS (ACID EXTRACTABLES)							
76. p-Chloro-m-cresol	<5	100	110	110	100	120	120
78. 2-Chlorophenol	<2	100	98	98	100	100	100
127. 4-Nitrophenol	<10	100	97	97	100	110	110
139. Pentachlorophenol	<50	100	88	88	100	88	88
142. Phenol	<2	100	90	90	100	97	97
SEMIVOLATILE ORGANICS (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	<2	50	55	110	50	55	110
88. 1,4-Dichlorobenzene	<2	50	45	90	50	49.5	99
102. 2,4-Dinitrotoluene	<50	50	53.5	107	50	55	110
105. N-Nitroso-di-n-propylamine	<5	50	60	120	50	65	130
145. Pyrene	<2	50	60	120	50	46	92
150. 1,2,4-Trichlorobenzene	<5	50	37.5	75	50	40	80

[a]Percent recovery = 100 x $(C_i-C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Non-confidential version of the Onsite Engineering Report of Treatment Technology Performance and Operation for Rollins Environmental Services (TX) Inc., Deer Park, TX (Reference 16).

Table A-1 (Continued)

MATRIX SPIKE RECOVERIES FOR NONWASTEWATER RESIDUALS

Spike Constituent	Original Amount Found (ppm)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)
METALS							
163. Nickel	<0.0249	2	1.61	80.5	2	1.59	79.7

[a]Percent recovery = 100 x $(C_i-C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Non-confidential version of the Onsite Engineering Report for Stabilization of F024 Rotary Kiln Incineration Ash at U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi (Reference 10).

Table A-2

MATRIX SPIKE RECOVERIES FOR WASTEWATER RESIDUALS

	Spike Constituent	Original Amount Found (ppm)	Sample Result			Duplicate Sample Result		
			Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)
VOLATILE ORGANICS								
4.	Benzene	<2	25	21	84	25	17	68
9.	Chlorobenzene	<2	25	29	116	25	23	92
24.	1,1-Dichloroethene	<2	25	12	48	25	11	44
47.	Trichloroethene	<2	25	21	84	25	27	108
SEMIVOLATILE ORGANICS (ACID EXTRACTABLES)								
76.	p-Chloro-m-cresol	<2	100	87	87	100	85	85
78.	2-Chlorophenol	<50	100	81	81	100	78	78
127.	4-Nitrophenol	<50	100	62	62	100	43	43
139.	Pentachlorophenol	<2	100	58	58	100	45	45
142.	Phenol	<2	100	74	74	100	70	70
SEMIVOLATILE ORGANICS (BASE/NEUTRAL FRACTION)								
52.	Acenaphthene	<5	50	51	102	50	51	102
88.	1,4-Dichlorobenzene	<2	50	34	68	50	35	70
102.	2,4-Dinitrotoluene	<2	50	43	86	50	42	84
105.	N-Nitroso-di-n-propylamine	<5	50	50	100	50	46	92
145.	Pyrene	<2	50	43	86	50	43	86
150.	1,2,4-Trichlorobenzene	<10	50	30	60	50	34	68

[a]Percent recovery = 100 x $(C_i-C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Non-confidential version of the Onsite Engineering Report of Treatment Technology Performance and Operation for Rollins Environmental Services (TX) Inc., Deer Park, TX (Reference 16).

Table A-2 (Continued)

MATRIX SPIKE RECOVERIES FOR WASTEWATER RESIDUALS

Spike Constituent	Original Amount Found (ppm)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[a] (%)
METALS							
163. Nickel	0.203	1.00	1.14	94	1.00	1.123	93

[a]Percent recovery = 100 x $(C_i-C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Draft Onsite Engineering Report for Horsehead Resource Development Co., Inc., Palmerton, PA, for K061. (Reference 13).

Table A-3

SUMMARY OF ACCURACY CORRECTION FACTORS

Constituent	Accuracy Correction Factor[a] Kiln Ash Residue Total Composition	Scrubber Water Total Composition
4. Benzene	1.18	1.47
21. Dichlorodifluoromethane	NA	1.28
34. Methyl ethyl ketone	1.06	1.28
38. Methylene chloride	1.06	1.28
42. Tetrachloroethene	1.06	1.28
43. Toluene	1.06	1.28
45. 1,1,1-Trichloroethane	1.06	1.28
47. Trichloroethene	1.00	1.19
215-217. Xylenes (total)	1.06	1.28
222. Acetone	1.06	1.28
226. Ethyl benzene	1.06	1.28
229. Methyl isobutyl ketone	1.06	1.28
51. Acenaphthalene	1.00	1.19
57. Anthracene	1.00	1.19
65. Benzo(k)fluoranthene	1.00	1.19
70. Bis(2-ethylhexyl)phthalate	1.00	1.19
80. Chrysene	1.00	1.19
87. o-Dichlorobenzene	1.00	1.19
88. p-Dichlorobenzene	1.11	1.47
98. Di-n-butyl phthalate	1.00	1.19
108. Fluoranthene	1.00	1.19
109. Fluorene	1.00	1.19
111. Hexachlorobutadiene	1.00	1.19
126. Nitrobenzene	1.00	1.19
141. Phenanthrene	1.00	1.19
142. Phenol	1.11	1.43
145. Pyrene	1.09	1.16
163. Nickel	1.255	1.075

[a]The accuracy correction factor is equal to 100 divided by the percent recovery. An accuracy correction factor of 1 was used when matrix spike and duplicate matrix spike recoveries both exceeded 100%, so that the data were not adjusted to concentrations below the detection limits.

NA - Not applicable.

Table A-4

ACCURACY-CORRECTED DATA USED TO CALCULATE TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 NONWASTEWATERS

BDAT List Constituent	Corrected Total Concentration[a] in RCRA Blend Waste Incinerator Ash (ppm) Sample Set: 1	2	3	4	5	6
VOLATILE ORGANICS						
4. Benzene	2.35	2.35	2.35	2.35	2.35	2.35
34. Methyl ethyl ketone	10.6	10.6	10.6	10.6	10.6	10.6
38. Methylene chloride	10.6	10.6	10.6	10.6	10.6	10.6
42. Tetrachloroethene	2.13	2.13	2.13	2.13	2.13	2.13
43. Toluene	2.13	2.13	2.13	2.13	2.13	2.13
45. 1,1,1-Trichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
47. Trichloroethene	2.00	2.00	2.00	2.00	2.00	2.00
215.-217. Xylenes (total)	2.13	2.13	2.13	2.13	2.13	2.13
222. Acetone	10.6	10.6	10.6	10.6	10.6	10.6
226. Ethyl benzene	2.13	2.13	2.13	2.13	2.13	2.13
229. Methyl isobutyl ketone	10.6	10.6	10.6	10.6	10.6	10.6
SEMIVOLATILE ORGANICS						
51. Acenaphthalene	2.00	2.00	2.00	2.00	2.00	2.00
57. Anthracene	2.00	2.00	2.00	2.00	2.00	2.00
65. Benzo(k)fluoranthene	2.00	2.00	2.00	2.00	2.00	2.00
70. Bis(2-ethylhexyl)phthalate	2.00	2.00	2.00	12.0	2.00	2.00
80. Chrysene	2.00	2.00	2.00	2.00	2.00	2.00
87. o-Dichlorobenzene	2.00	2.00	2.00	2.00	2.00	2.00
88. p-Dichlorobenzene	2.22	2.22	2.22	2.22	2.22	2.22
98. Di-n-butyl phthalate	2.00	2.00	2.00	230	2.00	2.00
108. Fluoranthene	2.00	2.00	2.00	2.00	2.00	2.00
109. Fluorene	2.00	2.00	2.00	2.00	2.00	2.00
111. Hexachlorobutadiene	10.0	10.0	10.0	10.0	10.0	10.0
126. Nitrobenzene	5.00	5.00	5.00	5.00	5.00	5.00
141. Phenanthrene	2.00	2.00	2.00	2.00	2.00	2.00
142. Phenol	2.22	2.22	2.22	2.22	2.22	2.22
145. Pyrene	2.17	2.17	2.17	2.17	2.17	2.17

[a]Constituent concentrations have been corrected by multiplying the concentration by the accuracy correction factor (ACF) for each constituent.

Table A-4 (Continued)

ACCURACY-CORRECTED DATA USED TO CALCULATE TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 NONWASTEWATERS

BDAT List Constituent	Corrected Total Concentration[a] in F024 Nonwastewater Treatment Residual (ppm)					
Sample Set:	1	2	3	4	5	6
METALS						
163. Nickel	0.031	0.031	0.031	NA	NA	NA

NA - Not applicable.

[a]Constituent concentrations have been corrected by multiplying the concentration by the accuracy correction factor (ACF) for each constituent.

Table A-5

ACCURACY-CORRECTED DATA USED TO CALCULATE TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 WASTEWATERS

BDAT List Constituent	Corrected Total Concentration[a] in RCRA Blend Waste Scrubber Water (ppm)					
Sample Set:	1	2	3	4	5	6
VOLATILE ORGANICS						
4. Benzene	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
21. Dichlorodifluoromethane	0.0026	0.0026	0.0055	0.0179	0.0026	0.0026
34. Methyl ethyl ketone	0.013	0.013	0.013	0.013	0.013	0.013
38. Methylene chloride	0.013	0.013	0.013	0.013	0.013	0.013
42. Tetrachloroethene	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
43. Toluene	0.0026	0.0041	0.0033	0.0059	0.0026	0.0026
45. 1,1,1-Trichloroethane	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
47. Trichloroethene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
215.-217. Xylenes (total)	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
222. Acetone	0.013	0.013	0.013	0.013	0.013	0.013
226. Ethyl benzene	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
229. Methyl isobutyl ketone	0.013	0.013	0.013	0.013	0.013	0.013
SEMIVOLATILE ORGANICS						
51. Acenaphthalene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
57. Anthracene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
65. Benzo(k)fluoranthene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
70. Bis(2-ethylhexyl)phthalate	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
80. Chrysene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
87. o-Dichlorobenzene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
88. p-Dichlorobenzene	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
98. Di-n-butyl phthalate	0.0024	0.0075	0.0055	0.0050	0.0032	0.0030
108. Fluoranthene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
109. Fluorene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
111. Hexachlorobutadiene	0.012	0.012	0.012	0.012	0.012	0.012
126. Nitrobenzene	0.006	0.006	0.006	0.006	0.006	0.006
141. Phenanthrene	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
142. Phenol	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028
145. Pyrene	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023

[a]Constituent concentrations have been corrected by multiplying the concentration by the accuracy correction factor (ACF) for each constituent.

Table A-5 (Continued)

ACCURACY-CORRECTED DATA USED TO CALCULATE TREATMENT STANDARDS FOR CONSTITUENTS PROPOSED FOR REGULATION IN K083 WASTEWATERS

BDAT List Constituent	Corrected Total Concentration[a] in K062 Wastewater Treatment Residual (ppm)					
Sample Set:	1	2	3	4	5	6
METALS						
163. Nickel	0.387	0.355	0.419	NA	NA	NA

NA - Not applicable.

[a]Constituent concentrations have been corrected by multiplying the concentration by the accuracy correction factor (ACF) for each constituent.